# Space Weather Technical Forecast

Issued on Wednesday, 27 March 2024 at 12:39 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Further Minor/Moderate radio blackouts (R1/R2) expected. A reducing chance of Minor geomagnetic storms (G1) as CME influence eases. Electron Fluence likely rising above the Active threshold later in the period.**

### Analysis of Space Weather Activity over past 24 hours

**Solar Activity:** Solar activity recorded at GOES16 and 18 was Moderate with AR3615 producing several M-class flares in past 24 hours, with the largest peaking at M1.9, observed at 26/1330 UTC. There are currently eight sunspot regions on the visible disc, with AR3615 the largest and most magnetically complex group (Fkc/Beta-Gamma-Delta), with some spot consolidation evident in recent imagery. All other remaining sunspot regions are small and simple. No significant Earth-directed Coronal Mass Ejections (CMEs) were observed in available coronagraph imagery over the last 24 hours.

**Solar Wind / Geomagnetic Activity:** The solar wind at L1 measured by ACE and DSCOVR were initially strong (above 600km/s) after the recent CME that arrived on the 24th March, before a steady decline to Elevated levels, currently near 500km/s. The solar wind density has been at average levels. The IMF was at weak levels, less than 8nT. Bz was weak and mostly positive with a few short periods of negative, +5nT to -3nT. The phi angle has been positive (away from the sun) throughout. The net result of the above solar wind measures was Unsettled to Quiet (Kp1-3) geomagnetic conditions.

**Energetic Particles / Solar Radiation**: Solar radiation was below the S1 threshold.

High energy electron flux (greater than 2MeV) observed at GOES16 was at Normal Background levels. The observed 24-hour fluence was below the Active threshold, with a value at 27/0001UTC of 2.07e6 integrated pfu.

### Four-Day Space Weather Forecast Summary

**Solar Activity:** Moderate solar activity is expected, with further M-class flares expected from primarily the highly active AR3615 through the forecast period, with a slight chance of isolated X-class flares.

**Solar Wind / Geomagnetic Activity:** A CME associated with the X1.1 flare from a broad region north of AR3614 on the 23rd March, produced a complex halo CME which arrived at L1 at 24/1410UTC. There are no other Earth-directed CME's currently in the forecast.

Solar winds are currently at Elevated or Slightly Elevated levels are expected to continue to decline erratically through day 1 (27 Mar) as the impacts from the recent CME continue to wane. With any residual enhancement associated with CH12/- expected to be clearing. Wind speeds are expected to continue to fall towards background values during days 2 and 3 (28-29 Mar) in the absence of any further enhancements. Geomagnetic activity is expected to be initially Unsettled (Kp 3) with a slight chance of an Active (Kp 4) interval early on day 1 (27 Mar), steadily reducing to mostly Quiet (Kp 1-2) conditions throughout the remainder of the period.

**Energetic Particles / Solar Radiation:** High energy proton flux, as observed by GOES18 is continuing to decline from recent enhancement. A continued slow decline is expected in the

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absence of further significant flare activity.

High energy electron flux (greater than 2MeV) remains at background levels at first, given the ongoing HSS and recent CME influences. Activity is expected to increase given the solar winds likely to ease in coming days with a sharp increase likely to high levels by the end of the period. The associated 24-hour fluence is below Active threshold initially, but with an increasing likelihood of reaching Active fluence through the guidance period, becoming Expected by days 2-4 (28-30 Mar).

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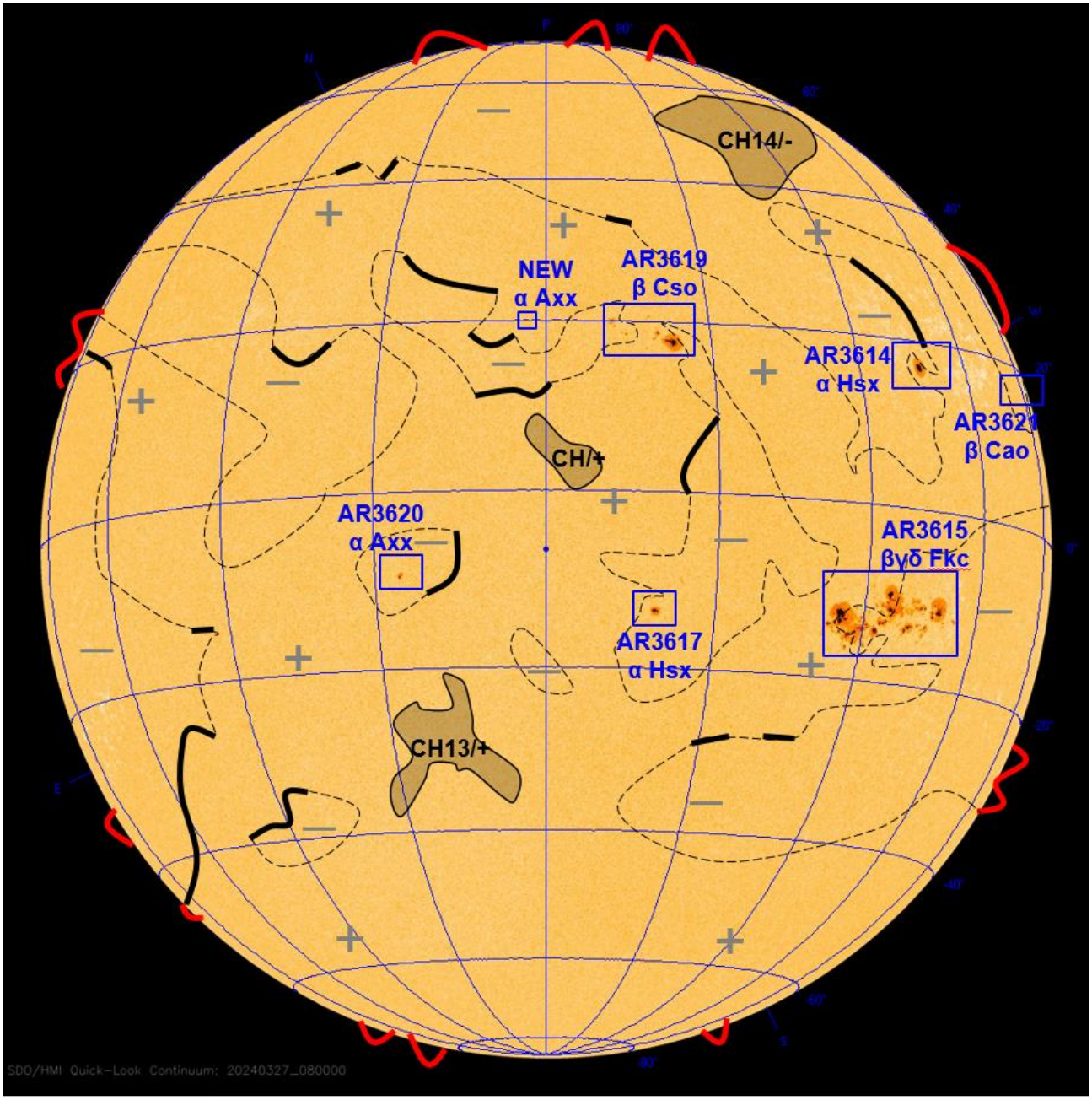
**Figure 1. Solar Analysis Valid 27/0800.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

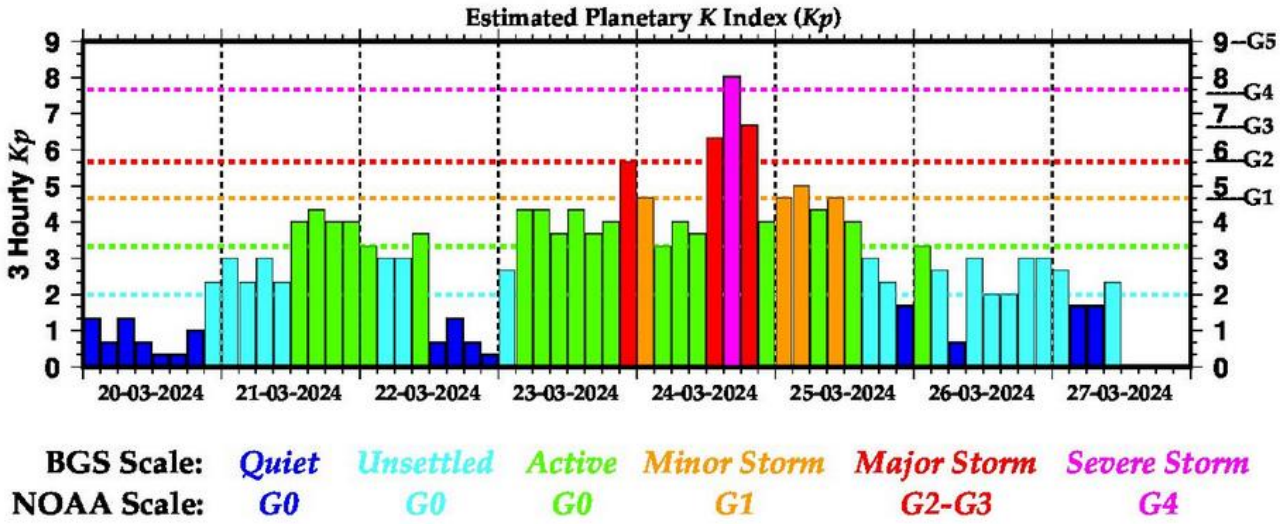
A CME associated with the X1.1 flare from a broad region north of AR3614 on the 23rd March, produced a complex halo CME which arrived at L1 at 24/1410UTC. There are no other Earth-directed CME's currently in the forecast.

Solar winds have reduced slowly but erratically, and are currently at Elevated to Slightly Elevated levels, near 500km/s. A continued slow and erratic decline is expected through day 1 (27 Mar) as the impacts from the CME continue to wane. With any residual enhancement associated with CH12/- expected to be clearing by that stage winds are expected to continue to fall towards background values into day 2 and 3 (28-29 Mar) in the absence of forecast enhancements.

Generally Unsettled to Active conditions expected initially, with a steadily reducing chance of G1/Minor storm conditions. From day 2 (28 Mar) conditions are expected to become generally Quiet (Kp1-2) in the absence of any further CME enhancements.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 20 | 1 | 1 | 1 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

**Figure 2: BGS plot of planetary K indices for the last 7 days.**

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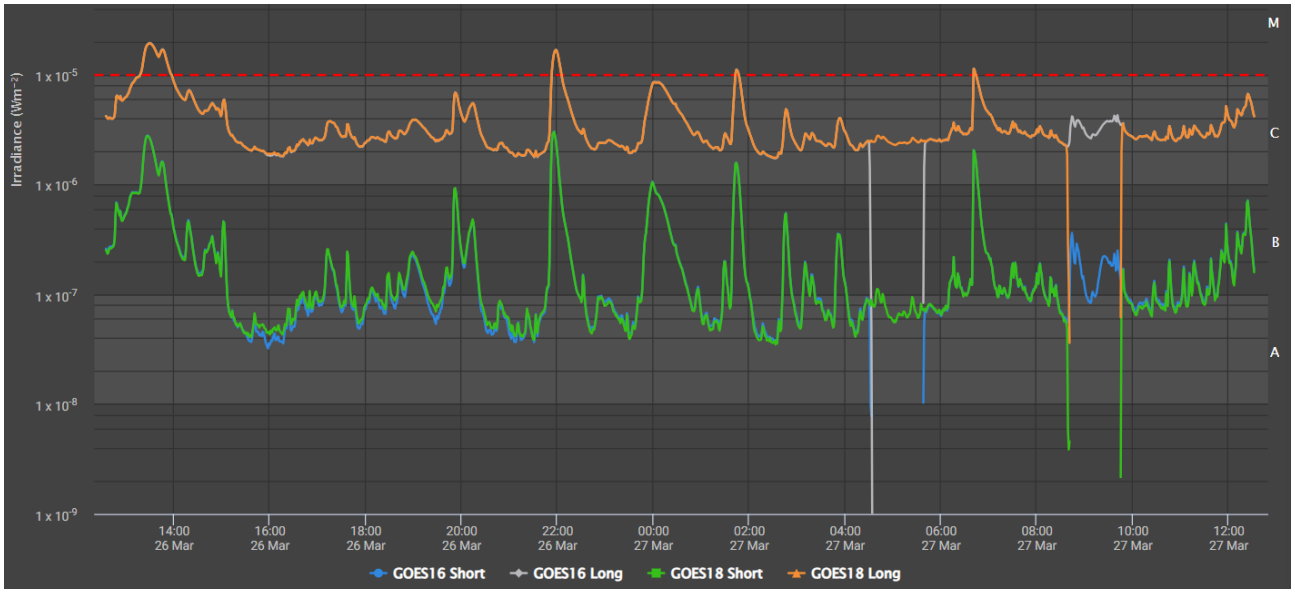
## Radio Blackouts - X-Ray Flares:

The current Earth-facing disc remains dominated by AR3615 (Fkc/Beta-Gamma-Delta), by far the largest and most complex group. This region has been highly active in recent days and has produced several M-class flares in the past 24 hours. The X1.1 flare on the 23rd was primarily associated with AR3614, which remains generally stable and much more magnetically simple, though it remains within a large plage region. All other regions remain significantly simpler, although recent flare and CME activity from AR3622 in the northeast indicate they should not be completely discounted.

AR3615 will remain on the visible disc throughout this guidance period, and will continue to represent a high risk of activity, with further M-class flares expected and slight chance of isolated X-class flares. Some suggestions from far-side sounding data that returning regions may rotate onto the southeast disk into the later half of the period.

| X Ray Flares<br>Probability | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| Active | R1-R2 M Class | Yes | 70 | 70 | 70 | 70 |
| Very Active | R3 to R5 X Class | No | 20 | 20 | 20 | 20 |

**Figure 3: GOES16-18 X-Ray flux trace for the past 24 hours.**

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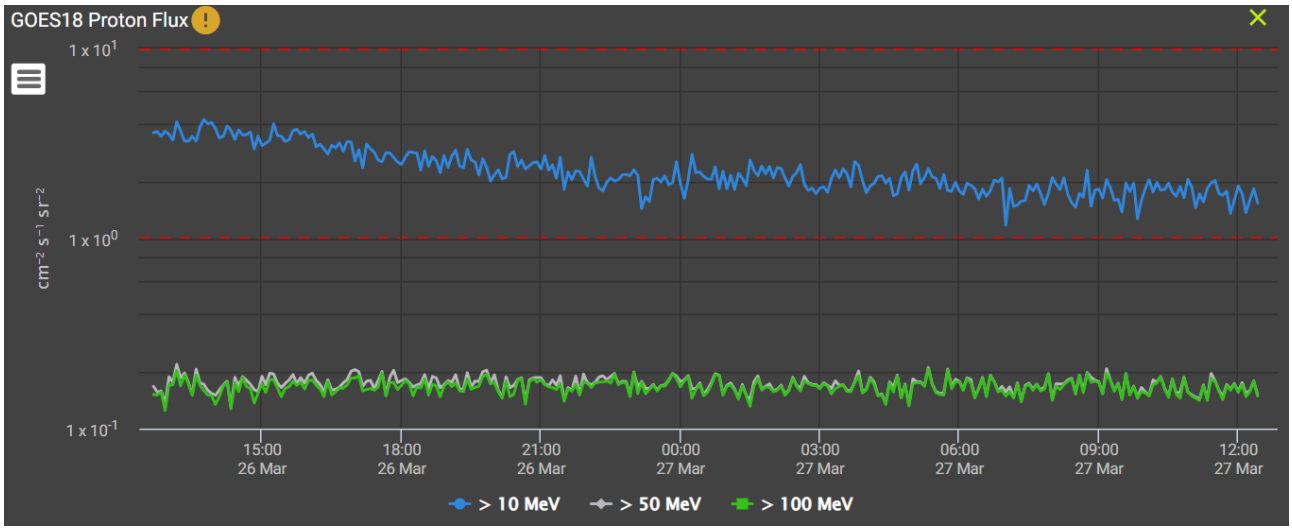
## Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES18 is continuing to decline from recent enhancement. A continued slow decline is expected in the absence of further significant flare activity, with the chance of any further enhancement dominated by AR3615 as it makes continued progress westward.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Active | ≥ S1 | No | 30 | 30 | 20 | 20 |
| Very Active | ≥ S3 * | No | 1 | 1 | 1 | 1 |

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

**Figure 4: GOES-18 Proton Flux**

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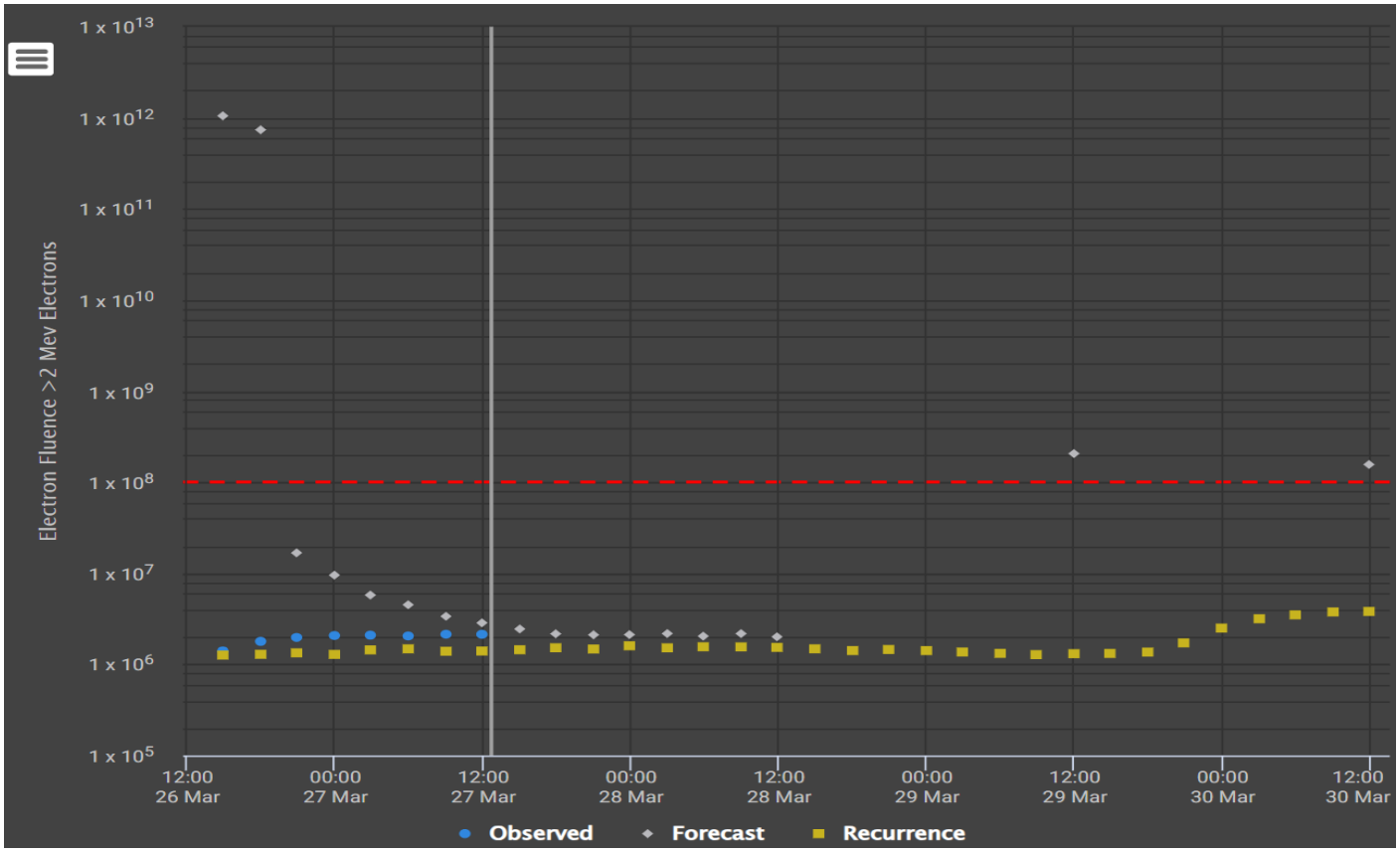
### High Energy Electrons Event (≥ 2MeV):

GOES16 high energy electron flux is at background levels currently given the likely ongoing connection to the HSS of CH12/- and recent strong CME passage. As geomagnetic activity and solar wind speeds likely ease over the next few days the electron flux at GEO is expected to quickly rise to Moderate or High levels.

The associated 24-hour fluence is currently below the Active threshold. Fluence is expected to rise sharply in the coming days with active fluence becoming increasingly likely. MOSWOC REFM output shows very high levels of forecast fluence day 1 (26 Mar), this is viewed as unlikely given likely ongoing fast solar winds. However, an increase in Fluence above the active threshold into days 3 and 4 (28-29 Mar) is accepted as good guidance.

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 50 | 60 | 80 | 80 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 5 | 10 | 15 | 15 |

**Figure 5: MOSWOC Electron Fluence - observations, forecast and recurrence.**

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